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Technological knowledge, concepts and attitudes in nursery school

Pierre-Henri Senesi
University Institute for Teacher Training, Nice, France

Abstract
This paper reports on research undertaken in a French school with children from 3 to 6, in order to determine assessment items for the teaching of design and technology. The aim of the research was both to know the way young pupils perceive materials, artefacts and making processes, and to evaluate the advance induced by making activities.

Among twenty one pupils from the three levels of French KS1, data about thirteen have been processed. A video-taped interview using objects was undertaken, the subjects then made some products in less than three hours. A similar interview was conducted following this.

A change in the way pupils perceive artefacts is measurable: they do not designate things as much by their names, customary function or shape but are more interested in their structures. They have an improved ability to analyse the artefacts. Their attitude toward technological outcomes has changed from a user’s to a producer’s one.

Nursery school programmes
Since 1995, the French national curriculum for nursery school (from ages 2 1/2 to 6), has included, among other items, ‘acting in the world’ (not on the world) and ‘discovering the world ... of matter ... and objects’. The world of matter appears to cover physics rather than technology (matter is not considered as material, no pragmatic action is described). Discovering the world of objects covers using, assembling, disassembling and making objects, and the use of construction kits (called construction games).

Teachers’ difficulties
Because technology is quite new to the French curriculum many teachers at this stage (French KS 1) have not been trained to teach either design or technology. Most of them studied humanities and do not feel able to face this (Raymond and Vignaud, 1986). They need technical knowledge, skills and attainment targets. Because they lack the theoretical basis to teach technology, teachers cannot analyse how their pupils learn in terms of concepts.

Concepts and attitudes
Learning technology can be much more than merely adding some more tricks and skills each year. It can be a way to build rationality, through confronting reality, but it can also help correct the ‘minority status’ (Simondon, 1989) which induces an observer/user attitude in young minds, instead of a technological one. The whole technical world is man-made, a response to people’s needs and wants. A computer is what it was designed to be. In this sense, it is different from what a mountain is. The project which brought about the former is different from the natural processes which brought the latter into existence. And the pre-primary school has to teach the core concept of a technological project which is the cornerstone of a new way of perceiving. Our purpose is to explore the way young children perceive their technical world, to find out which concepts they can build on and how their attitudes toward technology can be broadened.

Hypothesis
• Young children have inadequate conceptions about technical facts.
• Some acquisitions which are considered unusual, or even impossible for such young children are, in fact, possible, and can correct these misconceptions.
• These acquisitions enable children to change their attitudes toward technology,
to understand that an object was made in answer to a project, and that they themselves can be object-producers.

Methodology
Two similar nursery schools were selected; in one of them experiments were done with pupils who did not usually do design or technology. Fifty-one children from the three levels of French KS1 were engaged in technical activities, making products, over a 6 month period. A sample of twenty-three of them was interviewed and recorded by video before and after their work. Twelve children from the three levels in the second school had only the final interview. Among this sample, responses from only thirteen subjects from the first school have thus far been completely processed and are presented here.

Data collection
During each interview two subjects of the same age were interviewed together, except for one with a special educational needs girl, who was older. The teachers chose these children in order to cover the whole range of school standards. During both interviews, a number of objects were used, each presented one at a time, in order to generate discussion.

First interview
During the first interview, the objects presented were made of pieces of wood and plywood or objects including them. One of the pieces of wood had the bark taken off only on one side, it was sawn on the second and planed on the third side. A match stick, a toothpick, a small piece of plywood, a piece of pine dowel 20 mm in diameter, a 25 mm square piece of pine, a long cane of reed and three different spinning tops were presented. One of the spinning tops was made of a piece of dowel and a plywood disk, another one from a short pencil and a water bottle cap, the third from a match stick and a bottle cap. All of them worked. They are shown in Figure 1. The children were allowed to handle and play with everything.

Making things
Each pupil from both classes made some objects, whether the child was part of the sample or not. The objects were slightly different in the two classes, because of the age of the pupils and the room available for the activity. Each one made a spinning top and a fridge magnet (See Figure 2). Each subject in class #1 (levels 1, 2 and 3) also made a figurine cut out of plywood, and new paper out of recycled paper. Once they had drawn one, each subject in class #2 (level 3) made a wagon on wheels with its load (chassis shown Figure 2), and another object of the child’s choice was constructed with the teacher, built with glued half clothes-peg sticks.

All of them worked in plywood, plain wood, Styrofoam; some used paper, cardboard, plastic, steel sheeting and all cut with an electric fret saw, hot wire cutting, gluing, punching. Some of them sharpened pieces of dowel (with a pencil sharpener) in order to make axles for their spinning tops. Some of them crushed old paper in order to recycle it, some drove screws and some watched an adult drilling. Except for class #2’s free-choice object, the whole process was undertaken outside the classroom, without the teacher.
Second interview
Most subjects had learned a great deal during the first interview, and, in this short period, their answers showed increasing technical ability. The first results showed that the concept of material was not complete for most of the children. For instance, the cane was said to be a stick or ‘a piece of stick’, but rarely identified as wood. For most of them, none of the responses to the questions about the origin of man-made objects indicated that they had even the slightest notion the object could have been man-made.

The second interview was then set up in order to explore the concepts of material and man-made objects. Three different thicknesses of plywood, dowels of three different diameters made of two different kinds of wood, objects and pieces of Styrofoam of three colours, of thick glossy cardboard of three colours, of natural and painted wood; different spinning tops and other objects were used.

Processing the Data
The interviews were transcribed, to include verbalisations and acts. The items were:
- the way the subjects designated each object by its name, referring to its main function, by a geometric feature or in a symbolic or imaginary field;
- what they could say about its size and colour, except remarks about the material the object was made of;
- its structure;
- its origin: that it was bought, the fact that it may have been man-made, whether the subject felt capable of making it;
- knowledge of materials: name, grouping objects, finding ways to identify them, their origin and uses;
- the ability to say how artefacts could be made, including shaping and joining the parts (this part is not presented in this paper).

The objects
Results
During the first interview, subjects designated the objects by their real names (35%), with reference to their main functions (23%) or their geometrical shapes (17%), they also gave some names linked to designs or fictitious names (16%), and wrong names (9%). During the second interview, despite a greater number of objects (twice as many), designations came to about half the number in the previous step. The difference is significant (see chart below). Fictitious and design designations were now the most numerous (42%), before real names (29%), functional names (18%), inadequate names (8%), and a geometrical name (3%).

Functional designations (referring to the customary function: ‘It is used for ...’) decrease significantly, from 1.31 to 0.54 (p=0.02). Geometric designations (square, triangle ...) decrease significantly, from an average of 1 to 0.08 (p=0.04). Structural analysis scores increase significantly, from an average of 1.84 to 3.46 (p=0.01). Remarks about sizes are twice as frequent in the second test than in the first one: from 1.23 to 2.46 (p=0.03).

<table>
<thead>
<tr>
<th>Total designations</th>
<th>1</th>
<th>2</th>
<th>p</th>
</tr>
</thead>
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<td>Customary function</td>
<td>1.31</td>
<td>0.54</td>
<td>0.02</td>
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<tr>
<td>Geometric names</td>
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<tr>
<td>Structure</td>
<td>1.84</td>
<td>3.46</td>
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<tr>
<td>Sizes and dimensions</td>
<td>1.23</td>
<td>2.46</td>
<td>0.03</td>
</tr>
</tbody>
</table>

verbalizations about objects

Interpretation
The 50% decrease in naming the objects could come from the disappearance of a compulsory type of answer, or from a change in the subjects’ interests.

In the first case, we could postulate that the children are used to behaving in a given manner in school, giving answers according to the teacher’s expectations. In the new situation, this rule was replaced by another one because the experimenter did not ask usual questions, or give compliments or penalise any pupil whatever the answer. He did not use school material and worked in a room other than the classroom. For these children, working in a different way from usual, may account for the difference.
In the second case, which does not preclude the first one, we might suppose that the subjects feel a sort of familiarity with the objects presented more thoroughly, subjects could handle them more quickly (not yet measured) and have more technical ease in perceiving their structures. The sharp drop (p = 0.02) in references to the objects’ main function stands out. Children are very familiar with these objects’ customary functions, but are not familiar with the technical function of their parts (Sénési, 1994). This supposes that they are looking at things from a user’s point of view. Referring to it in the first test is probably an easy means of giving the experimenter a correct answer. The drop occurs as their interest in and ability for structural analysis rises (p = 0.01), yielding more accurate and complete descriptions of objects.

Some objects seemed to provoke feelings the children felt were too strong: many of them wanted to kiss the string-puppet bird and spoke with it as if to a person. Some of them were not able either to analyse its structure or explain how it was made, in spite of the fact that their other answers showed they could do so. For example, Mélanie (3 years 10 months at the date of the test) explains quite well that the puppet is hung on two pieces of wood joined to make a cross, and that pieces of string are knotted on the cross. But she appears to be unable to say anything about its structure or how the puppet itself was made. Robinson (6 years 0 month) admits that the flower he was shown is made of wood, but says that it smells good. Pauline (4; 8) says that it is not a real flower ... but adds that it is a flower.

Remarks about sizes and dimensions increased significantly (p = 0.03), but this can be explained by the materials used in the second test which included some items of different sizes. Nevertheless, the fact appears that most children, after a making period, can from themselves distinguish between close diameters and thicknesses. Some of the youngest described only two sizes: ‘big’ and ‘small’.

Materials

In some cases, the answers to the question 'What is it made of?' showed complete misunderstanding, probably due to a lack of concepts for materials.

In both tests, some samples of materials were recognised as matter and were given correct or acceptable names. On the other hand, in the second one only, the subjects spoke of them as materials that could be shaped by cutting, drilling or punching.

Some pupils appeared at first not to recognise wood around them: when asked to find some wood in the testing room, while seated on a wooden chair, in front of a wooden table, between wooden racks, cases and closets, some of them searched or mentioned trees. Yasmine (4; 3) showed the brown wallpaper, saying that it is wood. Both Yasmine and Deborah (4; 2), stood up and sat down twice in one minute when searching for wood in the room, each of them twice put their hand on the wooden back of the chair, without pointing to it. Tina (3; 7) reported that there is no wood at home. When she asked for wood and received a figurine made of wood, she was not satisfied. Diane (4; 7) contested the fact that the racks were made of wood, contrary to Mélanie’s claim.

In this country school, wood appears mainly to be perceived of as something found in trees, on the ground in the forest, or piled up in gardens. Before further questioning, its main use was reported as burning it in order to produce heat.

Some of the youngest subjects consider colours as real materials, these can be used to build things, and they describe some objects as made of ‘red, green and yellow’. It is really difficult for the youngest pupils in the first test to perceive the material behind a shape or a customary function.

Conclusion

Advances come quickly: the whole making time did not exceed three hours, varying slightly for each subject. The making was not
linked to other classroom activities, or reinforced by any work about the language used, and no time was allowed for designing. Both twenty-minute interviews gave rise to obvious learning.

This short time was sufficient to cause a noticeable advance in the way pupils perceive simple artefacts. Progress was made towards knowledge about technical actions which are elementary but basic (shaping and joining, not presented here). And, as a result, changes occurred in the subjects’ attitudes towards technological outcomes. They discovered two materials wood and Styrofoam.

Some other results which have not yet been proved to be significant were also found. They concern the objects’ ‘breakability’, the origin of materials and their uses, and correlations between these data.

Should the processing of the remaining part of the sample confirm these results, one could postulate that teaching and assessment of technological activities benefit from the following points:

• materials: a technological approach in both observation and action on materials seems to achieve results with minimum means;
• existing objects: this work developed the ability to analyse objects in these 3 to 6-year-old children;
• attitudes toward technology: these pupils became object-producers and consider themselves as such. New knowledge was acquired and created a basis for the mental re-construction of the objects’ properties, including how they were produced.

The greatest difficulty for these children was probably freeing themselves from their initial way of looking at things, whether social (name), functional (customary function) or symbolic.

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